MODIS Science Team Semi-Annual Report

Jan 1 – June 30, 2003

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Contract #: NAS5-31365

a) Task Objectives

Activities in this reporting period cover, completion of the Climate Modeling Grid Code, Collection 4 reprocessing and the initial period of AQUA operational production, the MODIS Burned Area code rewrite and updating the MODIS Fire Home Page. The MODIS Terra products continue to be validated and are being disseminated by the EDC DAAC. This period includes improvements to the Rapid Response System in preparation for the 2003 fire season, improvements to the Firemaps system, submission of direct broadcast code and collaboration with various users, through national collaborations and internationally through GOFC/GOLD, a project of the Global Terrestrial Observing System (GTOS). Emphasis has been on continuing evaluation of the products, determining product accuracy and outreach to users, answering questions and providing information on the product. Considerable attention has been given to coordinating the land product validation activities and outreach to the user community.

We continued to build the collaborations required to conduct the work of developing community consensus algorithms on Fire, Surface Reflectance which is an input to the MODIS Vegetation Indices. The project developed a number of collaborative activities that are intended to expand the scope of the team members' activities and involve a larger community in MODIS research and product validation.

Chris Justice participated in the Science Team Meetings, the Discipline Leaders meetings and whenever possible, the Land Science Data Development Team Meetings and the Technical Team (TT) Meetings. Chris Justice also represented the MODLAND group at the NASA Headquarters product review.

In addition, the goals of the MODIS project, the status of the instrument and the results of this MODIS supported research were presented at scientific meetings. MODIS results were presented at the annual GOFC/GOLD fire workshop at the University of Ghent. Results of the studies undertaken as part of the project are in the process of being written up and submitted for publication.

In agreement with the MODIS Project Scientist, resources from this project continue to support the MODIS Surface Reflectance product and the Fire Rapid Response System. This includes providing shared support for personnel and computer resources with Dr. E. Vermote, Dr. Jacques Descloitres and the Land Science Data Team at GSFC. During this reporting period, refinements to the current fire algorithm were investigated by Dr. Vermote.

b) Tasks Accomplished

1) Code Development, Delivery and Product Quality Assessment

Louis Giglio attended six MODIS Land SDDT meetings concerning code status, testing plans and development of quality assurance (QA) tools for the MODIS surface reflectance and fire products. He completed version 4.3.2 of the MODIS L2 fire code. This version fixes a minor bug in which the deliberate switching between band 21 and 22 was not always being performed properly.

Giglio continued work on the MODIS fire Climate Modeling Grid code following start of Collection 4 reprocessing on 20 December. This product will be generated at 0.25° spatial resolution on a daily and monthly basis, and will be released by the end of the year. If everything goes to plan this will be distributed from the Fire SCF allowing flexibility in format for the user.

Giglio delivered the stand-alone (non-ECS) version 4.3.1 of the MODIS fire code to the Direct Readout laboratory (Pat Coronado GSFC) in January. Direct Readout personnel then began distributing this version in mid-March.

Giglio continued quality assessment (and assurance) of Terra Collection 4 and Aqua Collection 3 fire products. No major problems were found. The LDOPE QA page was updated.

Mark Sullivan collaborated on the design and implementation of a scalable Scientific Compute Facility which supports the groups' Burned Area research, as well as a number of upcoming MODIS fire activities which will utilize very large volumes of MODIS and other satellite data. He is currently designing and implementing a flexible database system that will add MODIS data products to the toolset available to MODIS analysts in USDA. He also continues to refine and support the MODIS sub-setting, reprojection and mosaicking tool being used by the USFS. The tool is capable of producing HDF and GeoTIFF output.

2) NPP VIIRS (Giglio/Justice)

The MODIS fire group continued to support the NPP Fire algorithm activities. Giglio continued to evaluate the plans for VIIRS fire characterization and suggest alternative approaches to improving the instrument and algorithms for fire monitoring.

3) MODIS Active Fire Product Validation and Analysis (Csiszar) with contributions from Giglio, Justice and Dr. Jeff Morisette (NASA/GSFC).

The collaborative effort to validate the MODIS active fire products with coincident ASTER observations has continued. Csiszar developed software for the selection of processed coincident ASTER level-1b and MODIS data (MOD021km level-1b, MOD03 geometry and MOD14 fire product). Global sample data were obtained to achieve the Stage 2 validation for the active fire product. BIRD data was also obtained via. Deiter Oertel DLR for comparison with MODIS data.

4) Global Analysis of Active Fire distributions from MODIS (Csiszar) with contribution from Giglio

MODIS fire locations for the Rapid Response system were processed for the April 2001 to the present. In the analysis corrections for the change of sampling frequency with latitude and for missing data were introduced. The frequency of fire occurrence was determined for each month, and for each land cover type using the University of Maryland 1-km AVHRR Land Cover data set. A paper is currently being produced on these global distributions.

Lynn Dennis created daily and monthly fire count text files from the MOD14 collection 4 Active Fire Product for the years 2000, 2001, 2002, and 2003. She summarized these fire counts by country, hemisphere, region and used this data to create global fire count maps by country per month and by yearly totals. She also plotted graphs of the northern/southern hemisphere data by monthly totals and summarizing this data by various land cover types, percent tree, percent bare ground, percent herbaceous, T21 and T31 brightness values with the monthly summaries.

5) MODIS Burned Area Product.

1. MODAPS Code Development and Algorithm Refinement

The MODIS burned area algorithm, initially developed and tested to map burn scars for Southern Africa, has been modified and coded for global application. It uses both temporal and spectral information to map the area and the approximate date of burning. An improved rolling algorithm was implemented to improve the efficiency of the moving-window BRDF inversion and BRF prediction. In addition to applying the threshold and the temporal consistency constraint to time series of z-score, a criteria on the change of the burned area index and the near-infrared nadir reflectance is used to reject false detection. The temporal consistency of the burned area index is further checked to throw the noisy pixels and temporary changes caused by other factors. An investigation is also underway to reduce the effect of missing values and phenology on burned area detection. The algorithm was tested over Southern Africa and Australia and will be further tested in other regions such as Amazon and Siberia. Based on analysis of various regional tests, it will be refined toward a unified and robust global burned area algorithm.

2. Regional Test

The regional burned area product at 500m resolution is being produced internally at the UMD Fire SCF, using the collection-4 MODIS intermediate surface reflectance data from 2001. The band selection was investigated for 8 MODIS tiles in Northern and Western Australia, as well as the sensitivity of the burned area mapping to both the threshold of z-score and the duration days of persistence. The MODIS band 2 and band 5 are found to produce the best result when compared with the MODIS active fire product. Replacing Band 5 with Band 6 does not affect the burned area detection. The band 7 information is used by applying the persistence of the burned area index as a constraint. A threshold of 2.0 for z-score and a persistence of 4 to 5 days are found most favorable for burned area mapping over Australia. Overall the regional test over Australia shows that the spatial distribution of the MODIS burned area matches well with that of the MODIS active fire and the dates of burning identified by burned area product and active fire product are similar. The omission error of the burned area detection occurs when there are numerous missing values before or around the date of burning.

The MODAPS code will soon be used to produce 2003 regional burned area product using both Terra and Aqua observations as input. The combined observations are expected to reduce the missing values and increase the number of observations for BRDF inversion and thus to improve the accuracy of the burned area detection.

3. Validation Activities

International collaborations were established with regional fire monitoring sectors in Australia, such as Bushfire Council of the Northern Territory and Department of Land Administration (DOLA). The validation regions and the corresponding Landsat scenes within a month apart were identified through discussions with Australian scientists who have rich knowledge of Australia fire regimes. 12 Landsat scenes were collected and an order of 13 more scenes was placed to represent the diversity of land cover types and fire regimes over Australia. The regional validation is underway with the burn scars mapped form these high resolution Landsat imageries as reference. The validation protocol formed by Dr. Roy from Southern Africa experiences will be followed to validate the MODIS burned area product. In addition, the fire histories mapped from 4 Landsat scenes in the Top End over approximately 10 years and the fire map from NOAA-AVHRR by the

Australian collaborators were requested and will be compared with the MODIS burned area product.

6) Transitioning MODIS Land Rapid Response System to Operational Status in NOAA

Justice and Csiszar continued to work on establishing a formal arrangement between NASA, NOAA, the Earth Science Interdisciplinary Center and the Department of Geography to facilitate the transition of MODIS RR data and methods to NOAA.

7) SAFARI 2000 campaign and MODIS regional emissions (Korontzi) with contributions from D. Roy (UMd)

Stefania Korontzi continued her research on dynamic modeling of fire emissions from southern African savannas using the experimental MODIS burned area product for southern Africa (provided by D. Roy UMd). Intercomparison of the GBA-2000 European Space Agency and the MODIS burned area products were continued within the context of emissions modeling. Korontzi has completed her analysis on seasonal emission factors from savanna fires. Furthermore, she has developed an integrative database of emissions factors in southern African savanna fires, using results from the SAFARI-92, SAFARI 2000 and her own work. She is currently preparing a manuscript that will present fire emissions during the SAFARI 2000 dry field campaign.

8) MODIS Fire Science and Applications Outreach

There is in increasing use of MODIS fire data for fire management applications.

Concerning the algorithm and code, Giglio assisted M. Schmidt (Comision nacional para el conocimineto y uso de la biodiversidad), A. Marks (CSIRO Land and Water Environmental Remote Sensing Group), S. Chaomin (National University of Singapore), M. Conner (Air Force Weather Agency), W. Schroeder (Instituto Brasileiro do Meio Ambiente), R. Wright (Hawaii Institute of Geophysics and Planetology), Y. Nikulin (Altai State University, Russia), and K. Prasad (SeaSpace Corporation) with various aspects of the MODIS fire detection algorithm, the Rapid Response fire code, and the MODIS fire products.

Chris Justice worked with Emilio Chuvieco to co-chairs of the EARSeL SIG on Fire/GOFC-GOLD Workshop in Ghent. MODIS posters were presented by Ivan Csiszar and Stefania Korontzi. Extensive discussions were held on a MODIS fire danger product and current fire product validation. Justice met with M. Schmidt of the Comision nacional para el conocimineto y uso de la biodiversidad (CONABIO) diagnose various problems his group was having running the Rapid Response codes on their MODIS Direct Broadcast. Giglio also assisted A. Marks of the CSIRO Land and Water Environmental Remote Sensing Group in Australia to diagnose a few fire-code-related problems his group was experiencing. Justice held discussions with CSIRO concerning broader use of MODIS data.

During this period planning was initiated for the MODIS presentations at the SAFNET Workshop (August) and the Global Parks Congress (October) in South Africa and the NEESPI/GOFC-GOLD Workshop in Khabarovsk (September), Siberia.

During this reporting period the MODIS Rapid Response System was further developed as a contribution to the international GOFC/GOLD-Fire program. The UMD fire counts data base was updated using Collection 4 data and the ftp site streamlined.

9) Papers

9a) Recent Publications

Hély C., Alleaume S., Swap R. J., Shugart H. H. and. Justice C. O [3], 2003. SAFARI-2000 characterization of fuels, fire behavior, combustion completeness, and emissions from experimental burns in infertile grass savannas in western Zambia**. Journal of Arid Environments***,* 54 (2), 381-394

Hély C., Dowty P., Alleaume S., Caylor K., Korontzi S., Swap R.J., Shugart H.H., and Justice C.O. [3] (2003). Regional fuel load for two climatically contrasting years in southern Africa. **Journal of Geophysical Research***,* 108 (D13), 8475, doi:10.1029/2002JD002341.

Kaufman Y.J., Ichoku C., Giglio L., Korontzi S., Chu D.A., Hao W.M., Li R.R. and Justice C.O. 2003. Fires and smoke observed from the Earth Observing System MODIS instrument – products, validation, and

operational use. **International Journal of Remote Sensing** 24 (8), 1765-1781.

Korontzi S., Justice C. O. and Scholes R. (2003). Influence of timing and spatial extent of vegetation fires in southern Africa on atmospheric emissions, **Journal of Arid Environments**, 54(2), 395-404.

9b) In Press

Giglio, L., Descloitres, J., Justice, C. O., and Kaufman, Y. J., An Enhanced Contextual Fire Detection Algorithm for MODIS. **Remote Sensing of Environment,** in press.

Justice C. O., R. Smith, M. Gill, I. Csiszar. A review of current space-based fire monitoring in Australia and the GOFC/GOLD program for international coordination. **International Journal of Wildland Fire**, in press

L. Giglio, and Justice C.O. Effect of wavelength selection on characteristics of fire size and temperature. **International Journal of Remote Sensing**.

Korontzi S., D.E. Ward, R. A. Susott, R.J. Yokelson, C.O. Justice, P.V. Hobbs, E. Smithwick and W.M. Hao (2003). Seasonal variation and ecosystem dependence of emission factors for selected trace gases and PM2.5 for southern African savanna fires. **Journal of Geophysical Research**, in review.

S. Alleaume, C. Hély, , J. Le Roux, S. Korontzi, D. Roy, R.J. Swap, H.H. Shugart, and C.O. Justice (2003). Using MODIS to evaluate heterogeneity of biomass burning and emissions in southern African savannas: The Etosha National Park Case Study, **International Journal of Remote Sensing***,* in press.

C. Hély, P. Dowty, S. Alleaume, K. Caylor, S. Korontzi, R.J. Swap, H.H. Shugart, and C.O. Justice (2003). Regional fuel load for two climatically contrasting years in southern Africa, **Journal of Geophysical Research***,* in press.

Giglio, L., Descloitres, J., Justice, C. O., and Kaufman, Y. J., An Enhanced Contextual Fire Detection Algorithm for MODIS, **International Journal of Remote Sensing** submitted.

10) Papers and Posters Presented

Validation of the MODIS active fire product by coincident ASTER observations in Southern Africa. **EARSeL SIG Fire/GOFC-GOLD Annual Conference,** University of Ghent, Belgium.

Regional Fire Monitoring and Applications, **NASA NEESPI Planning Meeting**, Susdal, Russia.